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*THE SUBORDINATION OF THE INDIVIDUAL
TO THE WELFARE OF THE SPECIES.*

The Foundations of Zoology. By William Keith Brooks, Ph.D., LL.D., Professor of Zoology in the Johns Hopkins University. Pp. viii + 339. (Columbia University Press. New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1899.)

THIS volume forms the fifth of the Columbia University Biological Series edited by Prof. H. F. Osborn and Prof. E. B. Wilson, and it is appropriately placed beside the well-known earlier memoirs which deal with historic, phylogenetic and ontogenetic evolution. The traditions of the series are sufficient warrant for the admirable editing, printing and general appearance of the volume.

The author arranges his work in fourteen chapters corresponding to thirteen lectures, the sixth being divided into two parts. The subjects which follow the introductory lecture are "Huxley, and the Problem of the Naturalist," "Nature and Nurture," "Lamarck," "Migration in its Bearing on Lamarckism," forming the titles of the second, third, fourth and fifth lectures. The sixth deals with "Zoology and the Philosophy of Evolution," and its second part with the views of Galton and Weismann. "Galton, and the Statistical Study of Inheritance" is the subject of the seventh, and "Darwin and the Origin of Species" that of the eighth lecture, the subjects of the remaining lectures being "Natural Selection and the Antiquity of Life," "Natural Selection and Natural Theology," "Paley, and the Argument from Contrivance," "The Mechanism of Nature" and "Louis Agassiz and George Berkely." The titles are quoted in full, inasmuch as it will be recognised that the author's arrangement is unusual, both as regards treatment and the choice of some of the subjects. The same observation is true of the separate lectures: we everywhere meet with interesting views and modes of statement which are individual and original, and evidently represent the deep personal convictions of the author upon subjects to which he has devoted much time and thought. It may be questioned, however, whether the printed lecture is not an inconvenient form in which to address a wider audience than can be gathered in any hall or theatre. The spoken lecture is the best of all forms of communicating ideas, because we have the speaker's personality associated with his thoughts. But the form of a lecture is in large part determined because its substance is conveyed so easily and rapidly by speech and hearing. The same idea must often be repeated in different words, in order that it may be grasped and remembered before passing to others; and an argument may, and often should, be drawn out and enforced at a length which would be unnecessary and even tedious in a printed memoir. The lecturer has the great advantage that he can omit or expand according as he realises the extent to which his audience is in touch with him. When ideas are conveyed in print, the conditions are, of course, entirely different. When the reader does not fully understand, he can pause and reflect, and can read

again without losing the sequent ideas. Hence the form can, and should, be far more terse and condensed, and the argument does not need the same enforcement, while the repetition so necessary in a lecture is apt to become irritating.

Allowing for these qualities, which are essential to a lecture, the chapters are most interesting and stimulating.

In estimating the life-work of Huxley, the author rightly places in the foreground the great and successful struggle for intellectual liberty.

"To what nobler end could life be devoted than the attempt to show us how we may 'learn to distinguish truth from falsehood, in order to be clear about our actions, and to walk sure-footedly in this life.' If he has succeeded, and every zoologist who is free to follow nature wherever she may lead is a witness that he has succeeded—if, as the end of his lifelong labour, intellectual freedom is established on a firmer basis—this is his best monument, even if the man should quickly be forgotten in the accomplishment of his end. No memorial could be more appropriate than the speedy establishment of that intellectual liberty which is not intellectual licence on a basis so firm that the history of the struggle to obtain it shall become a forgotten antiquity" (p. 35).

Space prevents further allusion to the interesting criticism of Huxley's philosophy, and the statement of the particular parts of it which have proved to be of the highest value to the author.

"The interminable question whether 'acquired characters' are inherited" is not directly attacked by the author; but it is indirectly attacked in an extremely interesting and effective way. Granted that such inheritance is possible, the author inquires how far it is of value in accounting for the facts of natural history, and concludes that it is of no importance. The third lecture especially deals with this subject, although it recurs in various places throughout the volume. The discussion opens with a most appropriate reference to the teachings of Aristotle.

"Herbert Spencer tells us that the segmentation of the backbone is the inherited effect of fractures, caused by bending; but Aristotle has shown ('Parts of Animals,' I., i.) that Empedocles and the ancient writers err in teaching that the bendings to which the backbone has been subjected are the cause of its joints, since the thing to be accounted for is not the presence of the joints, but the fitness of the joints for the needs of their possessor. It is an odd freak of history that we of the end of the nineteenth century are called upon to reconsider a dogma which was not only repudiated two thousand years ago, but was even then antiquated."

The writer warns us that the tendency of exclusive laboratory teaching may be to lead us to forget Aristotle's principle; and he devotes the whole of this most important chapter to the demonstration, from the discussion of numerous examples, that the problem of fitness is the real problem which confronts the naturalist, and that it is entirely untouched by the explanation of nature as inherited nurture. The chapter concludes with a most convincing reply to the opposing arguments of an English writer. The author unfortunately omits a reference to the publication from which he quotes. The same omission is to be noted in other cases, as in the quotation from Agassiz on p. 16.

In the chapter on Lamarck a powerful argument is derived from "adjustments to the life of other beings than the ones which exhibit the adjustment," such as the poison-fang or sting, which are valuable to the possessor because of their effect on other species. The author finds "the production of adaptations of this sort by the inheritance of the beneficial effects of use, or in any way except by selection, quite unthinkable." Henslow's volume, "The Origin of Floral Structures through Insect and other Agencies" (Internat. Scientific Series) does not appear to be known to the author, although by a few well-chosen examples he shows the futility of the supposed origin which is therein suggested.

"For all I know, the Lamarckian may claim that the visits of insects have, in some way, modified the flower, to its own good, by their mechanical action, by pulling down this part, and by pushing up that, generation after generation, until they have caused adaptive modification in the flower. I do not know how much his ingenuity may be able to make out of this hypothesis; but no one can believe that the hooks and spines, which are so obviously adapted for distributing burrs and seeds, by fastening them to the fur of passing mammals, have been produced by the inheritance of the effects of this sort of mechanical contact; for these structures do not come into use until they are dead; and, most assuredly, dead things cannot transmit 'acquired characters' to their descendants. When a drop of rain or dew falls on the dead, dry, twisted glume of the animated oat (*Avena sterilis*), it untwists in such a way as to push like the leg of a grasshopper, and, raising the seed, to send it off with a jump. After the seed has fallen, this process is repeated again and again, until the heavy end, where the seed is placed, falls at last into some roughness in the ground, when the glumes begin to kick and to struggle, and, catching in the grass and roots, or on the rough ground, to push the seed down and to plant it. The seed is alive, but the glumes are dead and dry, and as completely out of the line of descent to future generations as the dead leaves which drop from the tree."

This quotation illustrates the very effective manner in which the Lamarckian principle is dealt with. In certain striking cases it is shown to be obvious that the hypothesis of Lamarck cannot supply an explanation, while selection offers a probable solution. At first sight these examples may appear to be exceptional and rare, but the author shows us that

"all the adaptations of nature are of this sort. In all cases, the structure, habits, instincts and faculties of living things, from the upward growth of the plumule of the sprouting seed to the moral sense of man, are primarily for the good of other beings than the ones which manifest them."

In support of this conclusion, the evidence of "the insignificance of the individual, as compared with the welfare of the species" is marshalled and illustrated in a peculiarly convincing and striking manner. Of all the examples, the most wonderful is certainly that of the queen-bee in her relation to the other members of the royal family and to the hive. A hive requires a queen, but would be disorganised by the presence of more than one queen at the same time. Until the queen-mother has led out a swarm, the workers will not permit a young queen, although mature, to leave her cell. In order to preserve her from the reigning queen, she is walled up with layers of wax and fed through a small opening.

When swarming has occurred, a young queen is allowed to escape: she in her turn is impelled to kill the rest of the royal brood, but is prevented by the workers. Later on in the season, however, when it is no longer possible to swarm, the attitude of the workers entirely changes, and they now "incite her to destroy her rivals." And here we meet with a most wonderful adaptation. It is obvious that any royal larva may, under certain circumstances, benefit the hive by producing a reigning queen, or, on the other hand, under different circumstances, may be killed in order to prevent a danger to the community. The instincts of the royal larva are such that it prepares beforehand for the latter alternative, and facilitates its own murder without inconvenience or danger to the queen, by spinning an incomplete cocoon which exposes the soft abdomen to the sting. Darwin pointed out in the "Origin of Species" that the social Hymenoptera afford the most complete evidence of instincts which cannot be due to use-inheritance inasmuch as they are exhibited by the sterile workers, the offspring of drones and queens with quite different instincts. Brooks has used the same example with great effect to emphasise "the supreme importance of the species, and the relative insignificance of the individual." Darwin's conclusion is also put with remarkable force on p. 95. This most interesting and convincing chapter concludes as follows:

"Some may ask whether it may not be possible that while natural selection is the chief factor in the origin of species, there may still be a residuum to be accounted for by the 'inheritance of acquired characters.' For all I know this may be not only possible, but actually the case. I have never felt the slightest interest in *a priori* demonstrations of the impossibility of this sort of inheritance; and for all I know to the contrary, proof of its occurrence may be found at any time, although I know no good evidence of its occurrence. I had satisfied myself, long before the recent revival of interest in the matter, that whether it be a real factor or not, the so-called Lamarckian factor has little value as a contribution to the solution of the problem of the origin of species; and renewed study has strengthened this conviction."

It must be remembered, on the other hand, that such inheritance would require an inconceivably elaborate mechanism, which can hardly have arisen and been sustained in order to account for a factor which is of little value in evolution.

"Migration in its bearing on Lamarckism" is the title of the succeeding lecture. The same subject was treated of in one of the most fascinating of Wallace's classical essays upon natural selection. It is interesting to compare the two, and to recognise how very greatly the interpretation of this difficult problem has been elucidated by the younger zoologist. Wallace dwells upon the lines of bird migration in their relation to past geographical change, and to the special need for insect food during the breeding season. Brooks treats the problem as a part of the wide principle of the subordination of the individual to the welfare of the species; he doubts the dependence on geological change and the great importance of food, and makes the illuminating suggestion that security from the enemies of eggs and young is the controlling factor alike of bird and fish

migration, and he dwells on the risk to parents involved in the process.

"Long journeys are hazardous. Every Californian salmon which enters upon the long journey to the breeding ground is destroyed, and the whole race is wiped out of existence for the good of generations yet unborn. Very few shad ever return to the ocean, and storm and accident and ruthless enemies work their will on the migrating birds and decimate them without mercy; yet the dangerous return to safe breeding grounds still goes on, in order that children which are yet unborn may survive to produce children in their turn."

Want of space prevents any further criticism of this most interesting volume. Enough has been said to prove that all the lectures demand the serious consideration of every student of evolution.

It is a peculiar pleasure to the British naturalist to find the Darwinian principle illustrated and defended with such remarkable force and success by a distinguished American zoologist.

E. B. P.

A MODERN TEXT-BOOK OF OPTICS.

Lehrbuch der Optik. Von Dr. Paul Drude, Professor des Physik an der Universität Giessen. Pp. xiv + 498. (Leipzig: Verlag von S. Hirzel, 1900.)

PROF. DRUDE'S name is well known to English physicists. As a careful and exact worker, the author of a book on the Physics of the Ether, and the successor of Gustav Wiedemann in the editorship of the *Annalen der Physik*, he has already made a high reputation for himself, and the book now under consideration will serve to add to it. Text-books of optics, it is true, are numerous, and the reviewer is apt to think that of the making of many books there is no end. Prof. Drude's book, however, contains much that is novel—at any rate, to English text-books—and the student will find up-to-date information on many points of interest.

In some respects the book has much in common with the late Prof. Preston's well-known text-book; it gains, however, in the end as a treatise on the subject by the definite adoption of the electromagnetic theory, although it is, of course, in consequence, less complete in that it gives no account of elastic solid theories.

The first hundred pages deal with geometrical optics. After a clear statement of the fundamental laws, including the law of the minimum path, and Malus' law of orthotomic systems, we have a chapter on the geometrical theory of optical images. A definition of an optical image is given; it is then shown that the image of a plane is a plane, and hence the analytical relation between the position of a point and its image is found. From this, following Abbé and Czapski, the geometrical theory of a perfect image is developed clearly and concisely. Throughout this part the book runs on similar lines to Dr. Moritz von Rohr's "Geschichte des Photographischen Objectivs," recently reviewed in these pages (*NATURE*, vol. lxi. p. 511), though, of course, the more technical part is dealt with much more briefly than in Dr. von Rohr's book.

Further chapters deal with the formation of images by real rays and the effects produced by the limitations in the size of the pencils in the case of actual instruments.

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The chapter on optical instruments is perhaps rather brief, but it is not the main object of the author to describe these. Throughout this part the book is very different from anything yet published in English, and will well repay study; it is interesting to read and clearly written; at the same time, it is commendably brief, and contains little long or cumbersome analysis.

The remaining four hundred pages are devoted to physical optics. In the first section of this, which deals with the general properties of light, there is, with one exception, nothing particularly novel. The treatment of interference, diffraction, the geometrical theory of double refraction and the colours of polarised light follow the usual lines; it could hardly be otherwise. The whole is brought up to date, however; there is, for example, an excellent account of Michelson's echelon spectroscope, while the theory of the resolving power of an optical instrument is given in some fulness; it is all well done, though the English reader will not find much to make him prefer the book, as a text-book, to Preston. The one exception is the chapter on Huyghens' principle. In his elementary discussion on the rectilinear propagation of light, Dr. Drude makes a distinct step by adopting the methods given by Dr. Schuster (*Phil. Mag.*, vol. xxxi. 1891), while he completes the discussion by giving Kirchhoff and Voigt's solution of the problem of finding the disturbance at a given point due to disturbances existing at some previous time over a surface surrounding the point. To do this, he has, of course, to make use of the differential equation satisfied by the disturbances, and this is not found till a later stage in the book; but the student who has read sufficient mathematics to follow the proof will probably be acquainted with the fact that the differential equation quoted does represent wave motion, and will not find any logical difficulty in the order adopted, while the proof will put the whole theory of diffraction before him on a sounder basis. An English reader, however, who realises what he owes to Stokes in this matter, may be allowed to express surprise that there is no reference in Prof. Drude's work to the great paper on the dynamical theory of diffraction, published in 1849 in the ninth volume of the *Transactions* of the Cambridge Philosophical Society.

The second section of this part deals with the optical properties of bodies, and here the distinctive points of Prof. Drude's method show themselves. After a brief reference to the elastic solid theory of the ether and the difficulties to which it leads, he adopts formally the electromagnetic theory.

The optical disturbance at any point through which light-waves are passing can be represented by the periodic variations of a vector quantity, the light-vector, as Drude calls it, and in a transparent isotropic medium this vector follows the same laws as do the electric or magnetic force in an insulating body. The electromagnetic theory of light identifies the light vector either with the electric or the magnetic force. Drude adopts the first of the two alternatives.

In an æolotropic medium, a third vector, the rate of change of the electric displacement, or the electric current, needs to be considered—in an isotropic body this coincides in direction with, and is proportional to,